Functional Response of the Venus flytrap (*Dionaea muscipula*)

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Introduction

- Venus' fly traps (*Dionaea muscipula*) are carnivorous plants endemic to coastal North and South Carolina. The unique carnivorous nature of the Venus' flytrap has made it the subject of numerous studies; however, its ecological role as a predator has received little attention.
- C.S. Holling (1959) classified three types of functional responses, or ways in which predators respond to increased numbers or prey:

1. Type I, in which the predator feeding rate increases linearly with prey density up to a saturation point where the feeding rate levels off.
2. Type II, in which the predator must spend time searching for and processing each prey item creating a response that increases at a decreasing rate.
3. Type III, in which the predator's rate will not increase until a certain prey density is reached and then will not slow until saturation.

- The purpose of this study was to determine the functional response of *Dionaea muscipula* to changes in prey density.

Figure 1. Growth chamber with four trays of experimental plants

Figure 2. Two trays with covered experimental plants inside growth chamber

Methods

- Venus' flytraps were purchased from the Fly Trap Farm in Supply, North Carolina.
- Forty Venus' flytraps were grown individually in containers (diameter of 3 in., height of 2 ½ in) containing peat moss, sphagnum, and sand.
- The plants were distributed into trays inside a covered greenhouse chamber at CCU, and each tray was filled with at least 1 cm of distilled water to maintain moisture.

Functional Response:

First Run:

- Eight flytraps were assigned to each of five feeding levels: 0 crickets, 3 crickets, 5 crickets, 8 crickets, and 10 crickets.
- For standardization purposes, each plant was trimmed to have five traps. Plants with fewer than five traps were used for the 0-cricket level.
- Plants were distributed in trays within a plant growth chamber (Fig. 1). Lighting was controlled to 12 hours of lightness and 12 hours of darkness.
- Transparent cups covered each plant (Fig. 2). Each cup had a small square cut out from the side to ease prey insertion, and this square was covered with tape to avoid prey escape (Fig. 3).
- After each plant received the assigned amount of crickets, the following observations were made: number of open traps, percent of successfully closed traps, percent of unsuccessfully closed traps, number of prey alive, number of prey dead, and number of prey captured.
- Observations were repeated at least once daily for five days.

Second Run:

- A second functional response experiment was conducted in order to have more low-density prey treatments and help distinguish between Type I and II responses.
- The experimental groups were changed to the following feeding levels: 0 crickets, 1 cricket, 2 crickets, 3 crickets, 4 crickets, 5 crickets, and 8 crickets.
- Each plant was trimmed to have four traps per plant. Each feeding level had six plants.

Handling Time

- Twenty-one plants with open traps were divided into three groups of seven. Each group was assigned a form of prey introduction: manual placement of a live cricket into an open trap, manual false closure of an open trap, and a natural introduction.
- The time it took for the cricket, if available, to be captured was recorded.
- The length of each trap from the top of one lobe to the top of the other lobe was also recorded.
- Handling time was considered complete once the distance between lobes returned to the original length.

Abstract

Individual predators responds to increased levels of prey according to one of three functional responses according to ecological theory. We investigated how a carnivorous plant, the Venus' flytrap (*Dionaea muscipula*), responded to increasing numbers of insect prey (crickets) in two greenhouse studies. Individual flytraps having the same number of traps per plant captured at a rate that was directly proportional to increasing numbers of crickets as they became available (i.e., a linear response) until reaching an asymptote, after which they did not collect more prey. This Type I functional response curve displayed by flytraps was partly due to their long handling time after collecting prey (i.e., individual traps containing prey did not reopen for nine to eleven days). The Type I functional response of the Venus' flytrap indicates that flytraps function similarly to filter feeders.

Figure 3. Plant covered by a transparent cup with a small hole on side for prey insertion

Results

Functional Response:

First Run:

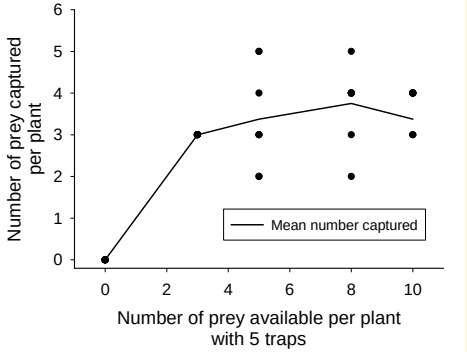

Figure 4: Functional response for First Run. Each symbol may represent more than one plant.

Primary Results from First Run

- The functional response curve increased and leveled off at the 5-cricket prey density (Fig. 4).
- However, the shape of the curve at lower prey densities was unclear.

Second Run:

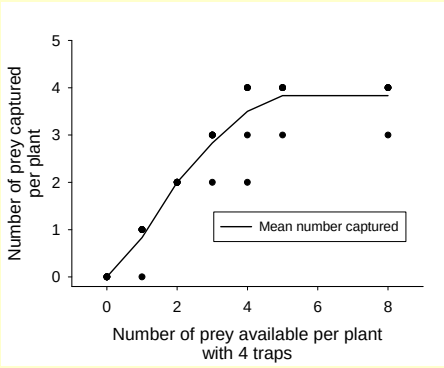

Figure 5: Functional response for Second Run. Each symbol may represent more than one plant.

Primary Results from Second Run:

- The functional response curve increased linearly until leveling off at the 4-cricket prey density (Fig. 5).

Handling Time:

- None of the traps reopened to the original distance across the lobes. Expansion either stopped or slowed drastically before meeting this length in each plant.
- As a result, it was difficult to determine when a trap was physically ready to close.
- Nevertheless, handling time for traps with prey inside ranged from 9 to 11 days.
- Traps with false closures reopened in as little as a few hours after the trigger to close.

Figure 6: Sampling in Lewis Ocean Bay Heritage Preserve, SC

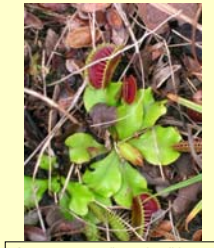

Figure 7: Venus' flytrap in wild

Conclusions

- Based on data from the first run (Fig. 4), we thought that the functional response could be a Type I or a Type II curve.
- The second run showed a linear, or Type I, response (Fig. 5).
- We concluded that predation increases linearly as long as there are open traps available for prey capture.
- Similarly, Jeschke *et al.* (2003) concluded that all filter feeders, including carnivorous plants, exhibit a Type I response.
- The observed handling time ranged from 9 to 11 days. Lloyd (1942) estimated that after prey capture, the lobes reopen over ten days.
- Traps manually closed without a prey item inside reopened within 24 hours.
- A Type I functional response ultimately suggests that although Venus flytraps cannot control a prey's population, this predator is capable of keeping up with an increase of prey density up to a certain level. On a wider scale, the entire population of Venus flytraps in an area is more effective as a predator when prey densities are at low to intermediate levels.

Works Cited

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